



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PU030273	FOR FURTHER ACTION		See Form PCT/PEA416
International application No. PCT/US2004/030745	International filing date (<i>day/month/year</i>) 21.09.2004	Priority date (<i>day/month/year</i>) 23.09.2003	
International Patent Classification (IPC) or national classification and IPC H04N7/26			
Applicant THOMSON LICENSING S.A.			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 8 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p style="margin-left: 20px;">a. <input checked="" type="checkbox"/> <i>sent to the applicant and to the International Bureau</i> a total of 3 sheets, as follows:</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p style="margin-left: 20px;">b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand 10.03.2005		Date of completion of this report 13.01.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840		Authorized Officer Heising, G Telephone No. +49 30 25901-407 <div style="text-align: right;">  </div>	

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/US2004/030745

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

Description, Pages

1-8 as originally filed

Claims, Numbers

2-7, 9-13 as originally filed

1, 8, 14, 15 received on 14.03.2005 with letter of 10.03.2005

Claims, Pages

9-11 received on 14.03.2005 with letter of 10.03.2005

Drawings, Sheets

1/2, 2/2 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
 4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/US2004/030745

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	2-5
	No: Claims	1,6-15
Inventive step (IS)	Yes: Claims	2-5
	No: Claims	1,6-15
Industrial applicability (IA)	Yes: Claims	1-15
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

- 1 The following documents are referred to in this communication, the document D5 was not cited in the international search report:

D1 : CHRISTINA GOMILA, ALEXANDER KOBILANSKY: "SEI message for film grain encoding" JVT OF ISO IEC MPEG AND ITU-T VCEG JVT-H022, 23 May 2003 (2003-05-23), pages 1-14, XP002308742 GENEVA, SWITZERLAND

D2 : CHRISTINA GOMILA: "SEI message for film grain encoding: syntax and results" JVT OF ISO IEC MPEG AND ITU-T VCEG JVT-I013 REVISION 2, 2 September 2003 (2003-09-02), pages 1-11, XP002308743 SAN DIEGO, CA, USA

D3: US-A-5 450 098 (OZ RAN) 12 September 1995 (1995-09-12)

D4: SCHOYER M K N ET AL: "Block position dithering in DCT-coded sequences" SIGNAL PROCESSING. IMAGE COMMUNICATION, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 8, no. 6, September 1996 (1996-09), pages 545-549, XP004047116 ISSN: 0923-5965

D5: GISLE BJONTEGAARD: "Addition of comfort noise as post processing", ITU-T SG 16, VIDEO CODING EXPERTS GROUP, DOCUMENT Q15B15, 8 Sep. 1997, pages 1-2, XP002319278, Sunriver, Oregon, USA

2 INDEPENDENT CLAIM 1

- 2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Document D1 discloses (the references in parenthesis applying to this document):

A method for reducing artifacts in a video stream (D1: page 2, paragraph 2 and 3, wherein the artifacts are coding artifacts, i.e. the missing film grain in the decoded images, thus the method of D1 is as well suitable for reducing artifacts), comprising the steps of: decoding the video stream (D1: figure 1, "Decoding"); and adding random noise (D1: page 5, equation 2 with "N is a random value") to at least one pixel in a picture in the video stream following decoding (D1: figure 1, "Film grain simulation" with page 3, section "film grain simulation (decoder)" and page 5, lines

13-15, including equation 1)

in an amount correlated to luminance information of at least a portion of a current picture (*D1: page 5, lines 22-30 including equation 2 with correlations/weighting factors p , q , r , s , and u and "All correlation factors depend on intensity of the decoded image". See also page 4 section "Noise intensity" regarding the dependency of the amount of noise on the image intensity.*).

3 INDEPENDENT CLAIM 8

- 3.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 8 is not new in the sense of Article 33(2) PCT.
Document D1 discloses (the references in parenthesis applying to this document):

A decoder arrangement for decoding a coded video stream to yield reduced artifacts, (*D1: page 2, paragraph 2 and 3, wherein the artifacts are the missing film grain in the decoded images*)

comprising: a video decoder for decoding an incoming coded video stream to yield decoded pictures (*D1: figure 1, "Decoding"*)

a reference picture store for storing at least one previously decoded picture for use by the decoder in decoding future pictures, (*D1: page 8, paragraph 4 and 5 "JM6.1a encoder" settings with "Number of reference frames: 2", thus the used corresponding decoder must have (implicitly) a reference picture store as well, if it will be able to decode the bitstream*)

a noise generator noise for generating random noise (*D1: page 5, equation 2 with "N is a random value"*) for addition to at least one pixel in a decoded picture (*D1: figure 1, "Film grain simulation" with page 3, section "film grain simulation (decoder)" and page 5, lines 13-15, including equation 1*)

in an amount correlated to [correlated to] luminance information of at least a portion of a current picture; (*D1: page 5, lines 22-30 including equation 2: "All correlation factors depend on intensity of the decoded image"*)

a noise picture store for storing the noise information for subsequent use by the noise generator (*D1: page 5, lines 31-36 and equation 2 and page 6, equation 3, wherein the noise of spatial and temporal neighbours is used to generate the noise at the*

current pixel position, to enable the reuse of the noise it must be stored for every pixel, thus a noise picture store is implicitly given)

a summing block for summing the noise generated by the noise generator with a decoded picture from the decoder (D1: "+" in equations 1, 2 and 3);

and a clipper for clipping the summed noise and decoded picture. (D1: a clipper is (implicitly) present in the scheme of D1: Since Gaussian noise of predetermined variance, i.e. without restriction to the maximum value of the noise amplitude, is added to the decoded pictures, it would have led to strong visible artifacts in dark and light regions of the output images, if they had not been clipped. As no such artifacts are visible in the images of figure 8 in D1 a clipper was used)

4 INDEPENDENT CLAIM 14

4.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject matter of claim 14 does not involve an inventive step in the sense of Article 33(3)PCT.

4.1.1 Document D2, which is considered to represent the most relevant state of the art to the subject matter of claim 14, discloses (the references in parenthesis applying to this document):

A decoder arrangement for decoding a coded video stream to yield reduced artifacts, comprising: (D2: page 1, paragraph 1)

a video decoder for decoding an incoming coded video stream to yield decoded pictures; (D2: page 2, lines 1-3)

a reference picture store for at least one storing at least one previously decoded picture for use by the decoder in decoding future pictures, (D2: page 5, paragraph 6 and 7 "JM6.1a encoder" settings with "Number of reference frames: 2", thus the used corresponding decoder must have (implicitly) a reference picture store as well, if it will be able to decode the bitstream)

a noise generator noise for generating noise in accordance with decoded pictures (D2: page 3, lines 1-5 and page 3, line 28 - page 4, line 13)

and bit stream information from the decoder for addition to at least one pixel in

the decoded picture (*D2: page 2, lines 1-3, "SEI message" is part of the bitstream*)

a picture store for storing an $N \times N$ pixel block picture average, where N is an integer, for use by the noise generator, (*D2: page 3, line 28 - last line*)

a summing block for summing the noise generated by the noise generator with a decoded picture from the decoder. (*D2: page 3, lines 1-5 with equation 1*)

- 4.1.2 The subject-matter of independent claim 14 differs from the disclosure of D2 in that :

The noise generator noise generates noise in an amount correlated to additive noise of at least one pixel in a prior picture;

- 4.1.3 The problem to be solved by the present invention may therefore be regarded as:

How to reduce the artifact of temporal flickering due to the added noise.

- 4.1.4 In view of D2 the solution proposed in claim 14 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

According to D2 its subject-matter is based on D1 (*D2: page 1, paragraph 3 and page 6, reference 1*). In D1 the problem is solved by correlating the amount of the current noise to the noise of the previous frame using a temporal correlation factor v (*D1: page 6, lines 6-11*).

- 4.1.5 Therefore, the features disclosed in D1 and D2 would be combined by the skilled person, without exercise of any inventive skills in order to solve the problem posed. The proposed solution in independent claim 14 thus cannot be considered inventive (Article 33(3) PCT).

5 DEPENDENT CLAIMS 6, 7, 9-13, 15

Dependent claims 6, 7, 9-13, 15 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT), see documents D1-D2 and the corresponding passages cited in the search report and D5 for claim 12.

6 DEPENDENT CLAIMS 2-5

The combination of the features of dependent claims 2-5 are neither known from, nor rendered obvious by, the available prior art. The reasons are as follows:

Claim 2 comprises the feature of "correlating the noise using a factor dependent on the temporal correlation of the current picture image with one of a previously displayed or decoded picture". D1 discloses the principle of temporally correlating noise using a correlation factor v , but is quiet about how the correlation factor is determined. D3 and D4 disclose the employment of a constant, signal independent temporal correlation factor. Although the principle of controlling a process dependent on the temporal correlation of the current picture image with one of a previously displayed or decoded picture is well known - for example, it is often used during motion estimation in a video encoder -, it is not obvious for the person skilled in the art to utilize this feature to determine the temporal correlation factor for adding noise in a post-processor after video decoding.

Since claims 3-5 depend on claim 2 their subject-matter is as well novel and inventive.

7 CLAIMS 1-15

Claims 1-15 disclose methods and apparatus for video decoding and post-processing applications. Therefore, the subject-matter of these claims is considered to be industrially applicable according to Article 33 (4) PCT.

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CLAIMS

- 1 1. A method for reducing artifacts in a video stream, comprising the steps of:
2 decoding the video stream; and
3 adding random noise to at least one pixel in a picture in the video stream following
4 decoding in an amount correlated to luminance information of at least a portion of a current
5 picture.
- 1 2. The method according to claim 1 further comprising the step of correlating the
2 noise using a factor dependent on the temporal correlation of the current picture image with
3 one of a previously displayed or decoded picture.
- 1 3. The method according to claim 2 wherein the correlation factor is established
2 in accordance with one of a luma or color component.
- 1 4. The method according to claim 2 further comprising the step of adding noise to a
2 color component of the picture in accordance with a luma component.
- 1 5. The method according to claim 2 wherein the correlation factor is first
2 established on an $N \times N$ pixel picture block basis (where N is an integer) prior to interpolation
3 of the additive noise.
- 1 6. The method according to claim 1 further comprising the step of adjusting the
2 noise based on the intensity of an $N \times N$ block (where N is an integer) of adjacent pixels.
- 1 7. The method according to claim 1 wherein the amount of noise is correlated
2 using an approximation of a Finite Impulse Response (FIR) filter.
- 1 8. A decoder arrangement for decoding a coded video stream to yield reduced
2 artifacts, comprising:
3 a video decoder for decoding an incoming coded video stream to yield decoded
4 pictures ;

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5 a reference picture store for storing at least one previously decoded picture for use by
6 the decoder in decoding future pictures,

7 a noise generator noise for generating random noise for addition to at least one pixel in
8 a decoded picture in an amount correlated to correlated to luminance information of at least a
9 portion of a current picture ;

10 a noise picture store for storing the noise information for subsequent use by the noise
11 generator.

12 a summing block for summing the noise generated by the noise generator with a
13 decoded picture from the decoder; and

14 a clipper for clipping the summed noise and decoded picture.

1 9. The decoder arrangement according to claim 8 wherein the noise generator
2 implements an instantiation of a Finite Impulse Response filter.

1 10. The decoder arrangement according to claim 8 wherein the noise generator
2 implements an approximation of an Infinite Impulse Response filter.

1 11. The decoder arrangement according to claim 8 wherein the noise generator
2 generates noise in accordance with decoded pictures and bit stream information supplied from
3 the decoder.

1 12. The decoder arrangement according to claim 8 wherein the bit stream
2 information comprises a quantization parameter.

1 13. The decoder arrangement according to claim 8 further including a second
2 picture store for storing an $N \times N$ pixel block picture average, where N is an integer, for use
3 by the noise generator.

1 14. A decoder arrangement for decoding a coded video stream to yield reduced
2 artifacts, comprising:

3 a video decoder for decoding an incoming coded video stream to yield decoded
4 pictures ;

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5 a reference picture store for at least one storing at least one previously decoded picture
6 for use by the decoder in decoding future pictures,

7 a noise generator noise for generating noise in accordance with decoded pictures and
8 bit stream information from the decoder for addition to at least one pixel in the decoded
9 picture in an amount correlated to additive noise of at least one pixel in a prior picture;

10 a picture store for storing an $N \times N$ pixel block picture average, where N is an integer,
11 for use by the noise generator; and

12 a summing block for summing the noise generated by the noise generator with a
13 decoded picture from the decoder.

1

1 15. The decoder arrangement according to claim 14 wherein the noise generator
2 implements an instantiation of a Finite Impulse Response filter

Second Meeting: Sunriver, Oregon, 8-11 September 1997

Question: Q.15/16

Source: Telenor Satellite Services
 P.O. Box 6914 St. Olavs plass
 N-0130 Oslo
 Norway

Tel:+47 23 13 83 81
 Fax:+47 22 77 79 80
 Email:gisle.bjontegaard@oslo.satellite.telenor.no

Title: Addition of 'comfort noise' as post processing

Purpose: Information

1 Introduction.

Video compression introduce coding noise. This noise is considered to be annoying from a subjective point of view. At the same time the noise gives some kind of (false) impression of sharpness. If we are able to remove most of the coding noise we often get an impression of a more 'blurred' picture. This happen even if we manage to leave details related to the picture content untouched by the filter. The intention of this document is to make the best out of this situation:

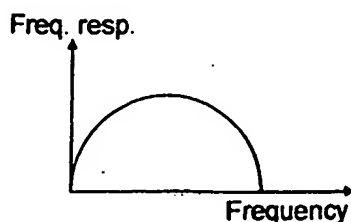
- First do post processing to reduce coding noise.
- Then add random noise to obtain an illusion of better sharpness. Random noise is considered to be less annoying to the eye. It is also similar to thermal noise that we are used to from analog video.

2 Definition of the 'comfort noise'.

I applied the noise filter after the other post processing - scanning the picture line by line. The operations may also be performed as a part of the last step of the post processing filter. The operations are :

- For each pixel generate a random number R_n in the range (0-1). R_0 and R_2 are the random numbers connected to the present pixel and to two pixels back.
- Calculate the integer: $I_1 = (3 \times \text{QUANT})/8$.
- Calculate a second integer: $I_2 = I_1 \times (R_0 - R_2)$ by truncation.
- Add I_2 to the luma value of the present pixel and limit to the range (0-255).

The reason for using $(R_0 - R_2)$ and not just R_0 is to give the noise a different frequency characteristic. The DC and high frequency part are suppressed resulting in a frequency response curve something like:



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 COUNTRY: PCT

3 Simulations.

The above procedure was applied to the QCIF sequences Mother&Daughter, Silent voice, and Coastguard. The effect on SNRs are shown in the table below.

Sequence	QUANT	SNRY with post processing and no added noise (dB).	SNRY with post processing and added noise (dB).
Mother&Daughter, QCIF	10	31.59	31.51
Silent voice, QCIF	14	30.57	30.36
Coastguard, QCIF	20	27.50	27.28

As expected the SNR values are reduced, but the effect on the tested sequences are only (0.1 - 0.2) dB. The sequences will be shown on D1 as a side by side presentation without and with the addition of noise.

4 Conclusions.

My personal opinion is that the described addition of noise may improve on subjective quality. It is expected that the assessment of the benefit is quite subjective. It is left to the group to decide whether the described approach or something similar may be worth describing in the test model.